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Abstract

New Aspects in the Application of Collision Probabilities in Reactor Theory

by

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During the past few years several computational methods involving the application of collision probabilities have been developed at the Siemens Reactor Department with the objective of basing the lattice calculational program on a common collision probability concept. The paper reviews these methods and describes some recent developments. In particular, it deals with problems associated with neutron spectra and physical lattice properties of heterogeneous media.

1. Starting from the integral transport equation describing the neutron flux as a function of space and energy, a set of N coupled integral equation is derived by subdividing the unit cell into N regions and introducing first-flight collision probabilities. By treating e.g. the integral expressions in an approximate manner the well known Wilkins thermalization theory for homogeneous media is extended to heterogeneous media. The resulting theory is reduced to a form which is readily accessible to numerical solution. The method is applied to some cases of practical interest.

   Similarly, on applying the above concept to the fast and epithermal energy region, the slowing-down calculational methods known as Greuling-Goertzel, Selengut-Goertzel and Fermi-Age approximations

can be readily generalized to heterogeneous lattice cells.

2. An alternate method of formulating neutron balance equations for a heterogeneous medium applies the concept of multiple collision probabilities.

   This leads to a generalization of Amouyal's and Benoist's (A & B) method for calculating the thermal utilization of a lattice cell. The outermost cell region can be treated either by diffusion theory (A & B) or integral transport theory.

   This method is further extended by introducing more than one energy group which results in a practical procedure for calculating the fast fission effect, taking into account back-scattering and fast interaction effects. - Theoretical results are found to be in very satisfactory agreement with experiments.

3. The practical applicability of all the afore-mentioned collision probability methods depends sensitively on the availability of methods adequate for calculating these collision probabilities to a reasonable accuracy. Simplified methods for computing these quantities, developed in the Siemens Reactor Department, are reviewed and discussed with regard to their accuracy.